UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 7
901 NORTH 5TH STREET
KANSAS CITY, KANSAS 66101

SEP 13 2010

MEMORANDUM

SUBJECT: Soil Preliminary Remediation Goals
AK Steel Site
Kansas City, Missouri

FROM: Jeremy Johnson, Toxicologist
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TO: Bruce Morrison, Project Manager
AWMD/RCAP

Per your request, we have developed soil Preliminary Remediation Goals (PRGs) for the AK Steel site located in Kansas City, Missouri. Surface soil and subsurface soil PRGs were developed for current and potential future receptors, including recreational users, industrial outdoor workers, and construction workers. The Integrated Exposure Uptake Biokinetic (IEUBK) Model and Adult Lead Methodology (ALM) were used to develop the lead PRGs for the recreational and worker scenarios, respectively. Below we have provided specific information on the development of these PRGs (e.g., exposure pathways and PRG equations) and our recommendations. Please note that the recommended lead PRGs for surface and subsurface soil should be used as the starting point for risk-based decision making. The final cleanup goal may be higher or lower than the recommended PRG based on further consideration of current and future land uses, uncertainties, and other site-specific information (see the Recommendations Section). Also, the same PRG may not be applicable to the entire site, which will depend on the land-use and location of the lead-contaminated areas. If you have any questions, please let me know.

Table 1. Recommended Lead PRGs (mg/kg)

Surface Soil PRG[1]	Subsurface Soil PRG[2]
1,531	1,531

[1] Based on the recreational user exposure scenario of 3 site visits per week.

[2] Given the potential for subsurface soils to be brought to the surface during construction and site redevelopment, the surface soil PRG is also recommended for subsurface soils.

Exposure Pathways

Current industrial land-uses are likely to remain at the site in the future. Also, although portions of the site are bounded by residential areas, it is reasonable to conclude that the site will not be used for residential purposes (i.e., homes). First, a large part of the site is heavily industrialized. In addition, the following site conditions also preclude the site from residential development, which include both the developed and undeveloped portions of the site.

- Several rail lines pass through and/or border the site.
- Portions of the site are bisected or bounded by the Blue River and Rock Creek.
- The site contains several landfills including a RCRA permitted landfill.
- Most of the site is located within the 100-year floodplain for the Blue and Missouri Rivers.

Despite these conditions, portions of the site, especially the northeast portion, have the potential to be frequented by trespassers/recreational users. The northeast portion of the site is undeveloped, vegetated, and bordered by three surface water bodies. Although site access is limited, this area of the site may be attractive to nearby residents, especially children and adolescents, for recreational purposes. Furthermore, individuals may use the site to access Rock Creek, the Blue River, and the Missouri River.

Based on the current and future land-uses, as well as the potential for the site to be visited by trespassers/recreational users, the industrial outdoor worker, construction worker, and recreational user exposure scenarios were selected to develop surface and subsurface soil lead PRGs. These scenarios represent the human receptors that will likely have the greatest exposures to lead in surface and subsurface soils. As a reminder, construction workers have the potential to be exposed to both subsurface and surface soils; therefore, the construction worker PRGs are applicable to both surface and subsurface soil. Also, the industrial outdoor worker scenario accounts for the commercial worker and indoor worker exposures scenarios.

Surface Soils – Industrial Outdoor Worker

The industrial outdoor worker PRG assumes exposures to soil will occur through ingestion of surface soils. Consistent with EPA lead risk assessment guidance, the industrial outdoor worker has an exposure frequency of 219 days/year and a soil ingestion rate 50 mg/day (USEPA, 1996). Additional exposure factors and their sources are provided below in Table 2.

Surface Soils – Recreational/Trespasser User

This scenario assumes a child visits the site three days per week during the warmest 6 months of the year (i.e., April – September). As a reminder, blood lead levels can reach "quasi-steady state" in 90 days, if the exposure frequency is no less than 1 day per week (USEPA, 1994, 1996, and 1999). It is assumed that a child between the age of six and seven years old (72 – 84

months) will be the youngest child to recreate on the site. However, given the site's proximity to residential neighborhoods (<quarter mile), children, adolescents, and adults that visit the site could potentially track surface soil back to their home where young children who do not visit the site may be exposed (USEPA, 2003). Therefore, a sensitivity analysis was performed on the recreational PRGs to determine if soils tracked back to the home would pose unacceptable health risks to younger children (see the Uncertainties Section and Attachment B).

Subsurface – Construction Worker

The on-site construction worker exposure scenario accounts for incidental ingestion. The soil ingestion rate for lead-contaminated soils is 100 mg/day (USEPA, 1999). The scenario also assumes an exposure frequency of 90 days over a period of four months (i.e., 120 days). Since exposures are expected to occur over four months, the averaging time for exposure is 120 days rather than 365 days in order to avoid diluting exposure (USEPA, 1999).

PRG Calculations

Recreational User – Surface Soil PRG

When evaluating intermittent exposures to lead, such as the recreational user scenario, a time-weighted average approach is used to develop the lead PRG (USEPA, 2003). This time-weighted approach consists of two steps and assumes that exposure to lead will occur at two locations, including the site and home (e.g., yard). The home exposure represents exposure to "background" soil lead. A background lead concentration of 49 mg/kg was used in the development of the recreational PRG. Additional information on the source of this value is provided in Table 2.

In the first step of the PRG development, a "weighted" soil lead concentration is derived. This concentration serves as the basis for the recreational user lead PRG. Given that this scenario accounts for a child that is less than 84 months in age (the most sensitive receptor to lead exposures), the IEUBK model is used to back-calculate the "weighted" soil lead concentration or residential soil lead PRG (PRG_{RSL}) (USEPA, 2009a). Consistent with the age group that visits the site, the IEUBK modeling only accounts for a child between the ages of 72 and 84 months. As a reminder, the PRG_{RSL} represents a soil lead concentration that will result in a no greater than five percent probability that a child's blood lead level will exceed 10 µg/dL (P10). Also, because site-specific information is not available for lead bioavailability, indoor lead dust concentrations, etc., the modeling relied on default values (see Attachment A for the PRG_{RSL} derivation).

Following the derivation of the "weighted" soil lead concentration or PRG_{RSL}, the recreational user PRG (PRG_{REC}) is calculated consistent with the equations provided in EPA's guidance document *Assessing Intermittent or Variable Exposures at Lead Sites* (USEPA, 2003). The equations and exposure factors are provided below and in Table 2. In short, the recreational user PRG reflects a concentration in site soil that when combined with exposures at home will result in an average soil lead concentration that equals the "weighted" soil lead concentration or

PRG_{RSL}. Thus, the PRG_{REC} is significantly affected by and dependent on the exposure frequency/fraction of the week spent at the site and home, as well as the background lead concentration at the home. Please note that the equations and the PRG_{REC} assume that on the days the recreational user visits the site, 100% of that day's soil ingestion will occur at the site. Also, soil ingestion is activity-based, so all of the day's soil intake could occur over a short period of time, such as the time spent at the site. See Table 3 below for the recreational user surface soil lead PRG .

Recreational Soil PRG Equations

$$PbSw = (PRG_{REC} \times \frac{EF_{rec}}{7days/week}) + (Pb_{yard} \times \frac{EF_{yard}}{7days/week}) \text{ (USEPA, 2003)}$$

$$PRG_{REC} = \frac{(PRG_{RSL} - (Pb_{yard} \times \frac{EF_{yard}}{7days/week})}{\frac{EF_{rec}}{7days/week}}$$

Where:
PbSw = Weighted soil-lead concentration = PRG_{RSL}
PRG_{RSL}= Residential soil lead preliminary remediation goal
PRG_{REC} = Recreational soil lead preliminary remediation goal.
Pb_{yard} = Average soil lead concentration near home.
EF_{rec} = Recreational exposure frequency (days per week spent at the site).
EF_{yard} = Yard (home) exposure frequency (days per week spent in yard).

Industrial Outdoor and Construction Workers – Surface and Subsurface PRGs

The EPA's Adult Lead Methodology was used to develop the soil lead PRGs (see Table 3 below) for industrial outdoor and construction workers. The ALM is designed to estimate fetal blood lead concentrations in women exposed to lead-contaminated soils. The PRG for lead (see the equation below) represents a concentration in soil in which there is no greater than a 5% probability that a fetus would have a blood lead concentration greater than 10 μg/dL (EPA, 1996). The ALM uses specific input parameters including soil ingestion rate, exposure frequency and duration, averaging time, Soil Lead Absorption Factor (AFs), Biokinetic Slope Factor (BKSF), Fetal/Maternal Blood Lead Concentration Ratio ($R_{fetal/maternal}$), Baseline Blood Lead Concentration ($PbB_{adult,0}$), and the Individual Blood Lead Geometric Standard Deviation (GSD_i). These input parameters are provided in Table 2 below.

Industrial Outdoor and Construction Workers Soil PRG equation:

$$PRG\ (mg/kg) = \frac{([PbB_{95}fetal/(R*(GSD_i^{1.645})])-PbB_{adult,0})*AT_{Pb}}{BKSF*(IR_{Pb}*AF_S*EF_{Pb})} \quad \text{(EPA, 1996)}$$

Table 2. Exposure Factors

Symbol	Definition	Units	Value	Source
$AT_{Pbconst}$	Lead Averaging Time- Construction Worker	days	120	USEPA, 1999
AT_{Pbout}	Lead Averaging Time- Industrial Outdoor Worker	days	365	USEPA, 1999
EF_{const}	Exposure Frequency – Construction Worker	days/yr	90	USEPA, 2002a
EF_{Pbout}	Exposure Frequency – Industrial Outdoor Worker	days/yr	219	USEPA, 1999
EF_{rec}	Exposure Frequency/Fraction of week spent at the site – Recreational User	days/week	3	BPJ
EF_{yard}	Exposure Frequency/Fraction of week spent in yard	days/week	4	BPJ
$IR_{Pbconst}$	Soil Ingestion Rate – Contact Intensive (Construction)	mg/day	100	USEPA, 1999
IR_{Pbout}	Soil Ingestion Rate – Non-Contact Intensive (Industrial)	mg/day	50	USEPA, 1999
PbSw	Weighted Soil Lead Concentration	mg/kg	684	Calculated [1]
PbS_{yard}	Average Soil Lead Concentration Near Home[2]	mg/kg	49	Tetra Tech, 2010
$PbB_{95}fetal$	95th Percentile PbB in Fetus	µg/dL	10	USEPA, 1996
R	Fetal/Maternal Blood Lead Ratio	-	0.9	USEPA, 1996
GSD_i	Geometric Standard Deviation	-	1.8	USEPA, 2009c
$PbB_{adult,0}$	Baseline Blood Lead Concentration	µg/dL	1.0	USEPA, 2009c
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4	USEPA, 1996

[1] Calculated using the IEUBK for a child between the ages of 72 and 84 months (USEPA, 2009a). See Attachment A.

[2] Mean background lead concentrations for nearby residences are not available. However, a mean background lead concentration was calculated from soil data collected from a residential area near the Former Amoco Refinery site (Tetra Tech, 2010). Given the close proximity of the Amoco site to the AK Steel site, the mean background lead concentration derived for the Amoco site is likely representative of the residential areas near the AK Steel site.

Table 3. Human Health Soil PRGs (mg/kg)

	Surface Soil		Subsurface/ Surface Soil
	Recreational User	Industrial Outdoor Worker	Construction Worker
Lead	1,531	2,240	896

Uncertainties

Several uncertainties have been considered during the development of these PRGs. Areas of uncertainty include, but are not limited to recreational exposures, construction worker exposures, and subsurface soil.

There are a couple uncertainties pertaining to the recreational user PRGs. First, it is uncertain whether recreational users visit the site as often as the exposure frequency used to

derive the PRGs. No definitive data is available on how often trespassers/recreational users visit the site and in response to this uncertainty, conservative exposure factors and assumptions based on best professional judgment were used to derive the recreational user PRGs. Also, it is uncertain that the recreational user will receive all of their daily soil ingestion during the days they visit the site. Some soil and dust ingestion may still occur at home on those days. However, it is worth noting that soil ingestion rates may be greater than default levels for some contact-intensive activities that may be typical of a recreational exposure scenario (USEPA, 2003). Furthermore, site soils can be tracked back to the home where young children (0-84 months) whom do not visit the site may be exposed. Although there are uncertainties associated with this pathway (i.e., the amount of soil, if any, that could be tracked home and the overall affect on indoor dust levels), a sensitivity analysis was performed on this pathway to determine the potential health risks. Based on our evaluation, the recreational user PRG of 1,531 mg/kg would not result in a P10 value above 5% for a child 0-84 months who is exposed to tracked in soil. However, lead concentrations equal to the industrial outdoor worker PRG of 2,240 mg/kg could result in a P10 value above 5% for the same scenario (i.e., a recreational user who visits the site three days per week). For additional information, see Attachment B.

Also, a great deal of uncertainty is embedded in the construction worker lead PRG. First, there is considerable uncertainty regarding the health impacts of short term exceedences of acceptable blood lead levels (Khoury and Diamond, 2003). Generally, the ALM and the IEUBK model evaluate long-term exposures to lead. Another source of uncertainty deals with the construction worker's exposure duration. In accordance with the ALM, the shortest exposure duration to approach quasi-steady state blood lead concentrations is 90 days when the exposure frequency is at least 1 day per week. Although construction work may last longer than 90 days, it is not known whether the same worker will be engaged in contact-intensive activities for a period of greater than ninety days. The PRG also assumes that the contact-intensive activities will only occur in the contaminated soil for the entire exposure duration. Construction work lasting several months, if any, will likely occur in both uncontaminated and contaminated soils. Therefore, the PRG for subsurface soil is likely to be overly protective.

Also, we are uncertain what impacts subsurface soil contamination may have on lead exposures in the future. Given the elevated concentrations of lead detected in some of the subsurface soils, there is the potential that if the subsurface soils were brought to the surface they could significantly increase surface soil lead concentrations.

Recommendations

As discussed and shown above, there are a range of soil PRGs for lead. However, there are a few key considerations that should be given to the PRGs provided in Table 3 and when selecting the final cleanup goals. First, setting cleanup goals that are higher than the recreational PRGs (e.g., industrial outdoor worker PRG) may present unacceptable health risks to recreational users and children (whom do not visit the site) that are exposed to soil tracked from the site to their home. Additionally, there are considerable uncertainties with the construction worker PRG. For these reasons, we recommend the recreational user lead PRG of 1,531 mg/kg for surface and subsurface soils, the latter under the assumption that subsurface soils are brought

to the surface during construction or site re-development. Also, please be aware that OSWER is re-evaluating the health protection goal of a P10 no greater than 10 µg/dL because adverse health effects have been demonstrated at blood lead levels down to 5 µg/dL, and possibly lower. Additional information on this issue can be found in the transmittal memo for the *Update of the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters*, which are both available on-line at http://www.epa.gov/superfund/lead/products/almupdate.pdf (USEPA, 2009b, c). Although we cannot speculate on whether a change will be made, it would significantly affect the lead PRGs if the goal is revised to no greater than 5% probability of exceeding 5 µg/dL. For example, the recreational user and industrial outdoor worker PRGs of 1,531 mg/kg and 2,240 mg/kg could drop to 560 mg/kg and 773 mg/kg, respectively (see Attachment C). Therefore, we recommend that the project management team stay informed of this issue and retain flexibility in the corrective measures implementation phase of the site clean-up to account for the potential change in the health protection goal for lead-contaminated soil.

Attachments

References

Khoury, GA and GL Diamond. 2003. Risks to children from exposure to lead in air during remedial or removal activities at Superfund sites: A case study of the RSR lead smelter Superfund site. *Journal of Exposure Analysis and Environmental Epidemiology* 13: 51–65.

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U.S. EPA. 2009c. *Update of the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters.* Lead Committee of the Technical Review Workgroup for Metals and Asbestos, Office of Superfund Remediation and Technology Innovation, Washington, D.C. OSWER 9200.2-82.

Figure A-1. PRG_{RSL} (Target Blood Lead Goal of 10 µg/dL)

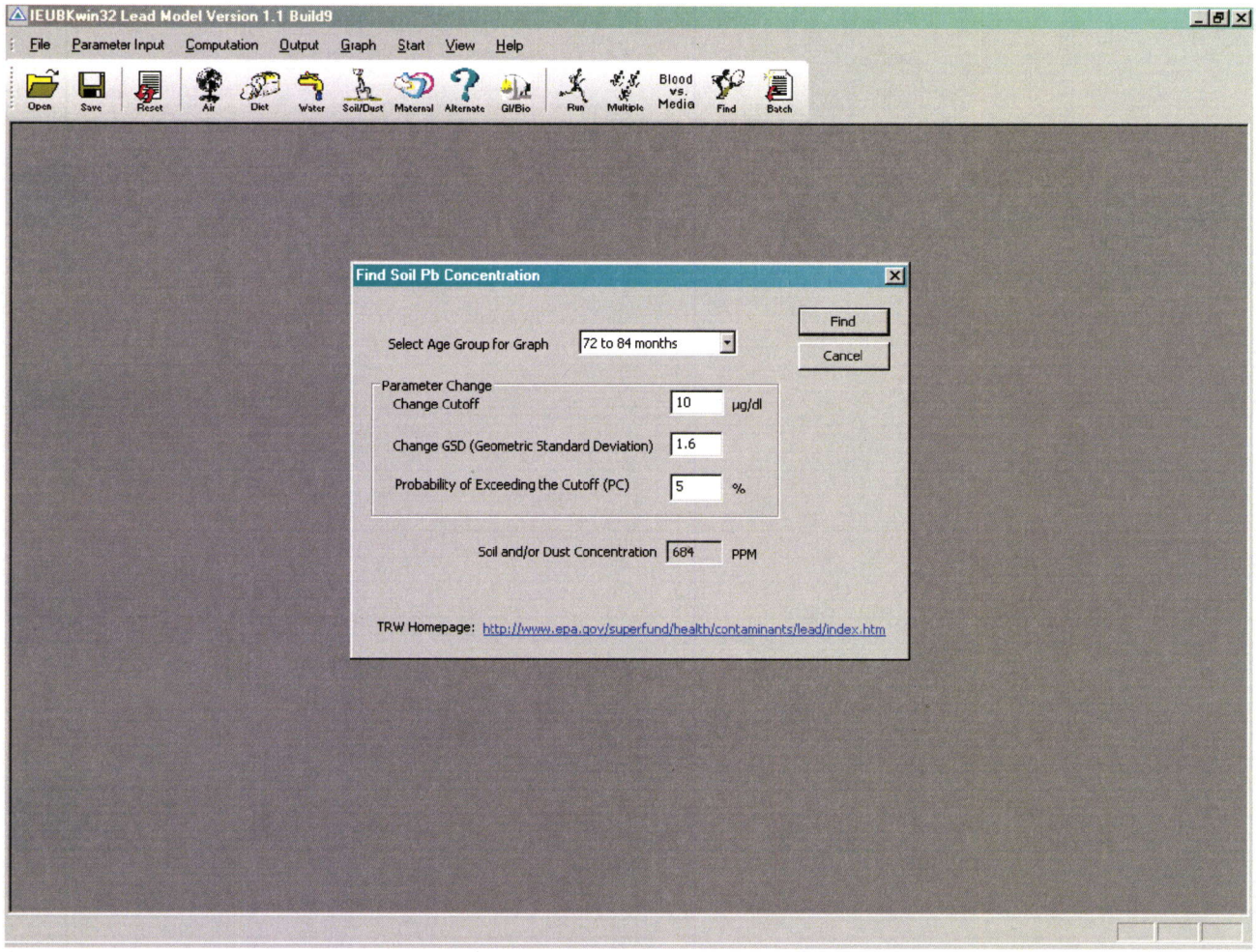
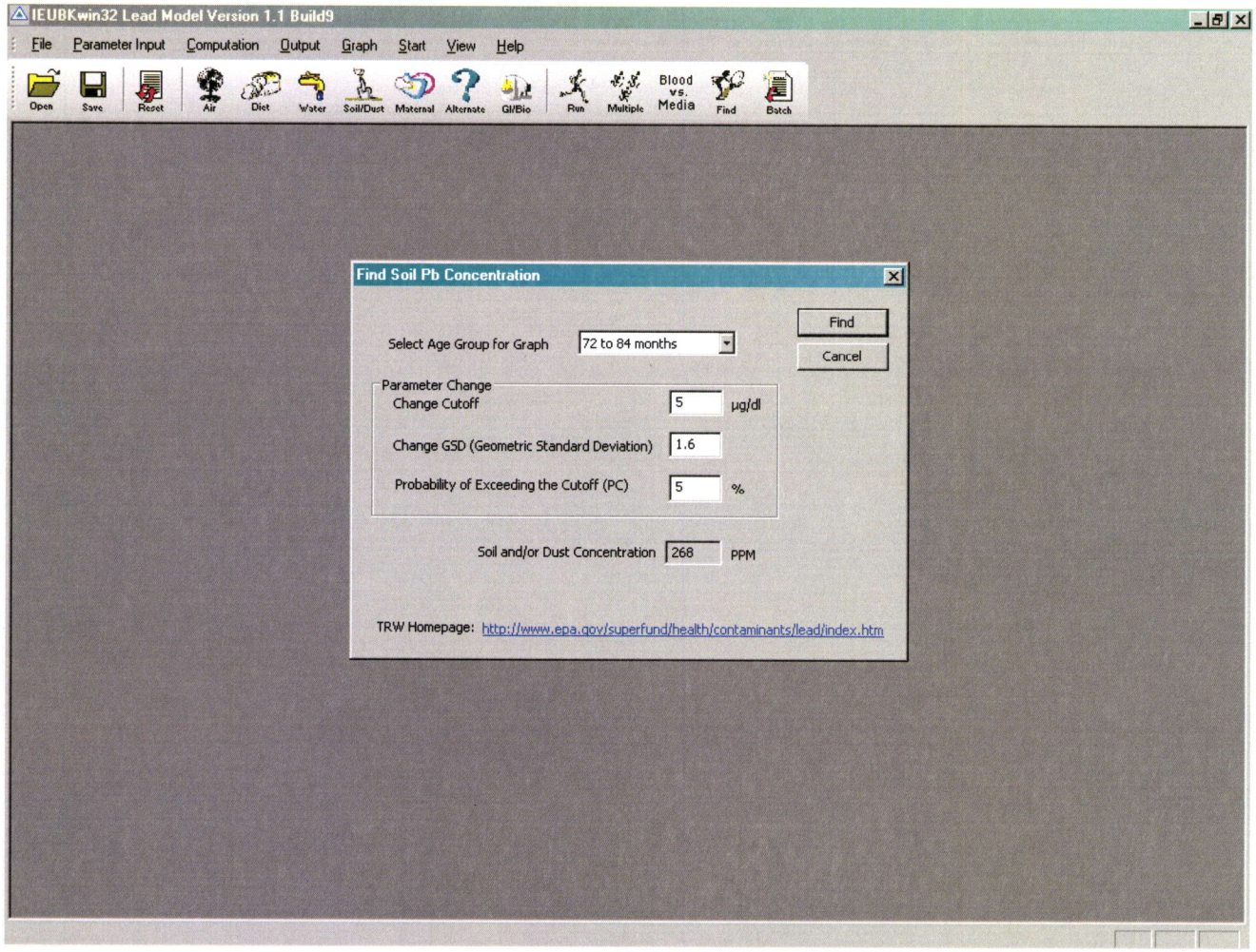


Figure A-2. PRG_{RSL} (Assuming a target blood lead goal of 5 µg/dL)



Attachment B. Sensitivity Analysis for a Child Resident's Exposure to Tracked-in Soil from the Site

Table B-1. P10 Values for Child Resident Exposure to Tracked-in Soil[1]

Industrial Outdoor Worker Soil Lead PRG (mg/kg)	Fraction of the Week Spent at the Site (TWF)	Weighted Soil Lead Conc. [2]	Child Resident Soil/Dust Ingestion Rates (g/day) [3]							Tracked-in dust alternate intake (µg/day) [4]							P10 [5]
			0-1yrs	1-2yrs	2-3yrs	3-4yrs	4-5yrs	5-6yrs	6-7yrs	0-1yrs	1-2yrs	2-3yrs	3-4yrs	4-5yrs	5-6yrs	6-7yrs	
2,240	3/7	960	0.085	0.135	0.135	0.135	0.1	0.09	0.085	31.4	49.9	49.9	49.9	37.0	33.3	31.4	>5%
2,240	2/7	640	0.085	0.135	0.135	0.135	0.1	0.09	0.085	20.9	33.3	33.3	33.3	24.6	22.2	20.9	<5%
2,240	1/7	320	0.085	0.135	0.135	0.135	0.1	0.09	0.085	10.5	16.6	16.6	16.6	12.3	11.1	10.5	<<<5%

Recreational User Soil Lead PRG (mg/kg)	Fraction of the Week Spent at the Site (TWF)	Weighted Soil Lead Conc. [2]	Child Resident Soil/Dust Ingestion Rates (g/day) [3]							Tracked-in dust alternate intake (µg/day) [4]							P10 [5]
			0-1yrs	1-2yrs	2-3yrs	3-4yrs	4-5yrs	5-6yrs	6-7yrs	0-1yrs	1-2yrs	2-3yrs	3-4yrs	4-5yrs	5-6yrs	6-7yrs	
1,530	4/7	874	0.085	0.135	0.135	0.135	0.1	0.09	0.085	28.6	45.4	45.4	45.4	33.7	30.3	28.6	>5%
1,531	3/7	656	0.085	0.135	0.135	0.135	0.1	0.09	0.085	21.5	34.1	34.1	34.1	25.3	22.7	21.5	<5%
1,531	2/7	437	0.085	0.135	0.135	0.135	0.1	0.09	0.085	14.3	22.7	22.7	22.7	16.8	15.2	14.3	<5%
1,531	1/7	219	0.085	0.135	0.135	0.135	0.1	0.09	0.085	7.2	11.4	11.4	11.4	8.4	7.6	7.2	<<<5%

[1] This approach assumes that a recreational user will track soils back to their home with lead concentrations equal to the industrial and recreational user PRGs where younger children whom do not visit the site may be exposed. This scenario is evaluted using the IEUBK model and accounts for a child's "background" exposure to lead (air, yard soil, dust, diet, and water) and the ingestion of tracked-in soil from the site via alternate source intake.

[2] Weighted soil lead concentration = average soil lead concentration that is tracked back to the home = PRG x TWF. Note that the weighted soil lead concentration is averaged over the entire week (i.e., 7 days) because the alternate source intake occurs daily in the IEUBK model. This assumes that the lead concentration in other soils and dusts tracked-in the home the remainder of the week (not including the yard soils, which is already accounted for in the IEUBK model) is zero.

[3] Soil/dust ingestion rates for children used in the IEUBK model.

[4] Tracked-in soil alternate intake = weighted soil lead concentration x default soil-dust ingestion rate x 0.7 x 0.55. Note, that the alternate intake of tracked-in dust assumes a (MSD) of 0.7 and indoor dust intake rate that is 55% of the total daily soil/dust ingestion rate. The MSD is the same as the MSD for dust derived from yard soil and the dust intake rate is equal to the daily dust intake rate used in the IEUBK model. Because of the limitations of the variables in the IEUBK model, dust ingestion may be double counted in these exposure scenarios.

[5] The P10 values account for a child aged 0 to 84 months whom is exposed to a background soil lead concentration of 49 mg/kg at their residence and to lead in site soils tracked-in to the home by older children. The latter is accounted for in the IEUBK model's alternate source intake and assumes an absolute bioavailability of 30% for the alternate source (i.e., site soils).

Attachment C - Soil Lead PRGs Assuming a Proposed Blood Lead Goal of 5 µg/dL.

Table C-1. Recreational PRG

EF_{rec} (d/wk)	EF_{yard} (d/wk)	PRG_{RSL} [1] (mg/kg)	Pb_{yard} [2] (mg/kg)	PRG_{REC} Equation	PRG_{REC} (mg/kg)
3	4	268	49	$PRG_{REC} = \frac{PRG_{RSL} - (Pb_{yard} \times \frac{EF_{yard}}{7 days/week})}{\frac{EF_{rec}}{7 days/week}}$	**560**

EF_{rec}: Recreational exposure frequency

EF_{yard}: Yard(home) exposure frequency

PRG_{RSL}: Residential soil lead preliminary remediation goal.

Pb_{yard}: Average soil lead concentration near home.

[1] Residential Lead PRG for a child between 72 and 84 months assuming a blood lead goal of 5 µg/dL. See Attachment A, page A-2.

[2] Mean background lead concentrations for nearby residences are not available. However, a mean background lead concentration was calculated from soil data collected from a residential area near the Former Amoco Refinery site (Tetra Tech, 2010). Given the close proximity of the Amoco site to the AK Steel site, the mean background lead concentration derived for the Amoco Site is likely representative of the residential areas near the AK Steel site.

Table C-2. Industrial Outdoor Worker Soil PRG for Lead

Variable	Description of Variable	Units	Worker PRG
$PbB_{fetal, 0.95}$	95th percentile PbB in fetus	ug/dL	5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	1.0
IR_S	Soil ingestion rate (including soil-derived indoor dus	g/day	0.050
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	219
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PRG		**mg/kg**	**773**